ploxylon, especially by the marked diminution in the diameter of the primary xylem, exhibit the secondary growth in roots, stems and leaf bases, but only as an elementary stage in the leaf itself.

Representing the present Brongniartian School, M. Renault cites the somewhat anomalous *Poroxylon* group ('although belonging rather to another series leading to the Conifera') as examples showing the double growth in roots, stems and leaves, predicting that their still unknown fruits will probably be found to be small seeds constructed on the plan already observed in the contemporaneous *Gymnosperms*. If so, the *Poroxylon* will be especially exemplary in combining the characters of *Phanerogams* and *Cryptogams*. The 'libero-ligneous' bundle of the leaf has the double structure in *Colpoxylon*, while the structure is simple in *Medullosa*, a genus allied to the Cycads, though both have lost all traces of their centripetal wood, except some vascular bundles scattered through the pith, the woody element of the stem being composed of tracheids punctate in many rows and medullary rays organized like those of the *Cycads*. He concludes that the Phanerogamic characters became gradually associated with the Cryptogamic, increasing little by little to preponderancy and finally exterminating the latter; that these changes are successively accomplished in the principal organs of the plant and in a definite order, the fruits being last to change. In effect, M. Renault suggests that the difference between the Paleozoic Lycopod group and the living Cycad is hardly more than that between the living Cycad and the typical Phanerogam. DAVID WHITE.

THE EMBANKMENTS OF THE RIVER PO.

THERE is probably no part of the world in which the action of rivers in carrying and depositing sediment can be better seen and more readily studied than in the plains of Lombardy and along the adjacent shores of the Adriatic, and no district has contributed more to our knowledge of the important subject of river action and delta building than has this portion of Northern Italy.

In this well settled country the very rapid advance of the land upon the sea everywhere has been especially remarked and could not escape the attention of the most unobservant, since, as is well known, the very town of Adria, which gives its name to the Adriatic Sea and which was a sea port in the time of Augustus, now lies 14 miles inland.

One statement concerning the chief of these Lombard Rivers, the Po, taken from chapter eighteen of Lyell's Principles of Geology, has been copied and recopied in one generation of text-books after another, a statement so remarkable that wherever met with it always arrests one's attention. It is that in which, after speaking of the action of the dykes, between which these Lombard rivers are confined in causing a portion of the sediment, which would otherwise be spread over the plains by the annual inundations, to settle in the bottom of the river channel, with the consequent necessity of from time to time increasing the height of the dykes, he says, "Hence it happens that these streams now traverse the plains on the top of high mounds, like the water of aqueducts, and at Ferrara the surface of the Po has become more elevated than the roofs of the houses."

On reading this passage one cannot but tremble for the fate of the city should the river break through its dykes, as it has already done on several occasions, and, being precipitated into the city, tear its way headlong to the sea.

A visit to Ferrara toward the end of May last served, however, to show that this danger is less imminent than might be supposed from Lyell's description.

The city of Ferrara has seen its best days; its population once numbering 100,000 has now dwindled away to less than 30,000, while great stretches of land within the walls are now quite deserted or used as kitchen gardens. The broad and ample streets and fine squares, as well as the noble cathedral, the numerous palaces and the great castle of the House of Este, however, serve to remind us of the former greatness of the city, with which are so intimately associated a number of the most distinguished names in Italian history, Savonarola, Ariosto and Tasso among the number.

The city is situated in the middle of the great plain of lower Lombardy, which so far as the eye can judge, is absolutely flat and which here is only six and a-half feet above sea level. The walls of the city, built of brick—for no good building stone is to be had in the alluvial plains in this vicinity—rise abruptly from the plain and are of no great height.

The plain all about Ferrara is very fertile, well cultivated and of extreme beauty, being intersected at regular intervals by long lines of poplars and pollarded elms festooned with vines, which also border the roads and separate the meadows and great fields of grain and hemp. The roads crossing the plains are well made and are raised considerably above its general surface, thus keeping them dry and in good condition.

The river Po, however, does not pass through the city of Ferrara, although it formerly passed near the city and in this vicinity branched, forming the Po Primario, whose mouth was at Ravenna, and the Po Volano, which debouched into the northern portion of lagoon of Comacchio. In the year 1152, however, the river broke through its dykes at Stellata, twelve miles and a half northeast of Ferrara and took a new course in the direction of the Venetian lagoons, which course, with some minor modifications, it has retained to the present time. By this change the Po Primario and the Po Volano were deprived of a great portion of their water, and the main stream now passes three miles and a half to the north of Ferrara, where it is crossed by the railway to Padua, at the little town of Ponte Lago Scuro, a busy little place, which is the chief port on the lower reaches of Po and which is connected by a bridge of boats with S. M. Maddelena, a village on the opposite bank of the river.

On approaching Ponte Lago Scuro from Ferrara the dykes which confine the river are first seen, crossing the flat country like a wall. The road at Ponte Lago Scuro is carried by a long incline nearly to the top of the dyke, the upper portion of which is cut through to allow the road to pass, and then by a steep descent on the inner side of the dyke the bridge of boats is reached, after crossing, which, by a steep rise and then a gentle descent, the plain beyond the river is once more gained.

The Po at this point is 285 yards wide, with a swift current sweeping rapidly by the boats, and the water at the time of my visit was very turbid from suspended mud, although it did not appear so turbid as the Arno at Florence or Pisa, and certainly not so muddy as the Missouri at Bismarck.

Watching it from the bridge as it sweeps by already near the sea and far from its source on Monte Viso, carrying great quantities of leaves, masses of weeds and branches of trees floating on its surface, a very vivid impression of the work which is being accomplished by the river is obtained. Although nothing in the way of actual erosion can be seen, no mountains or rising ground anywhere breaking the monotony of the plains. The long sand bars, seen from the top of the dykes, in the wider stretches of the river just above Ponte Lago Scuro, show that in flood time a large quantity of material too heavy to be carried in suspension is swept along.

The dykes or embankments which confine the river on either side are about 25 yards wide and rise in two, or sometimes three, terraces as approached either from the plain or from the river, as if a wide dyke of moderate height had just been made, along the summit of which a narrower dyke had subsequently been raised. The height of the dykes was estimated to be about 26 feet, and being well grassed over they do not present that strikingly artificial character which might be expected. An excellent road runs along the summit of the southern dyke. The dykes thus, although not so high as the majority of the houses in the villages on either side, overtop the smaller houses and outbuildings, while, standing on the bridge at the middle of the river, seven feet above the level of the stream, only the roofs and upper stories of the buildings on either side of the river can be seen.

With regard to the level of the waters of the Po as compared with that of the adjacent plains many contradictory statements have been made. The statement of Lyell that at Ferrara it was as high as the roofs of the houses was derived from Cuvier's 'Discours sur les Révolutions de la Surface du Globe,' although not quoted quite correctly, where the statement is made on the authority of M. de Prony, an Inspector-General of Bridges and Roads, who had been directed by the goverment to investigate the means of preventing the disastrous floods caused from time to time by the Po overflowing its banks.

These very old observations were subsequently shown by Lombardini in 1847 to be erroneous. This observer proved by accurate measurements that, at the time these were carried out, the mean height of the Po only here and there rose above the level of the plains and was generally considerably below it, and that even during the great flood in 1830 the surface of the river was scarcely ten feet above the pavement in front of the Palace at Ferrara (Geikie, Text-book of Geology, p. 368).

Since this time, however, these conditions have altered in a marked manner, the more recent investigations of Zollikofer having shown that in the normal condition of the river the surface of the water in the neighborhood of Ferrara is somewhat over 8 feet above the surrounding plains, while in flood time the water in some places rises from 16 to nearly 20 feet above the plain on either side (Kovatsch—'Die Versandung von Venedig'—Leipzig, 1882, p. 35).

At the time of my visit the surface of the water was certainly higher than the level of the plains, and the deep furrows in the dyke on the left bank of the river showed that in flood time the river now rises at least as high as the top of the first terrace of the embankment, which would be equivalent to the height given above by Zollikofer. That the river at times threatens to rise even higher is shown by the fact that where the upper terrace of the dyke is cut through to allow the passage of the road from Ferrara a brick wall has been constructed, so arranged that by the insertion of planks the highest level of the dyke may be maintained.

The city of Ferrara, therefore, although it might be subjected to disastrous inundation should the dyke on the right bank of the river break, is not so seriously threatened as might be inferred from Lyell's statement, and the Po, which in flood time 'hangs suspended, so to speak, over the surrounding plains,' is now much less dreaded than in times past, owing to the irrigating channels which tap it, as well as to a secondary series of lateral embankments which, placed at a considerable distance from the dykes on either side, border the whole course of the river below Cremona.

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